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THE CLINICAL EXAMINATION OF BREAST MILK.

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THE CLINICAL EXAMINATION OF BREAST-MILK.*

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New York.

THE importance of obtaining more exact knowledge of the variations in breast-milk has been for some years keenly felt by all those interested in the nutrition of young infants. The decision of the question regarding the ability or inability of the mother to nurse her child has so frequently to be decided by the general practitioner without special advice, that it is extremely important that there should come into general use a simple method for the examination of breast-milk, in order that infantile life and health may not be jeopardized by continuing lactation under circumstances when the milk is unfitted for the child's nutrition, and on the other hand in order that a recognition of what is wrong in the milk may enable the physician in some cases at least, so to modify the secretion by diet, habits of life, etc., as to make it meet the requirements of the child.

Pioneer work in the study of breast-milk has been done in this country by the former president of this society, Dr. T. M. Rotch, of Boston, and the importance of his work can hardly be over estimated. But not every physician is

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within reach of a competent analytical chemist, and not every family can afford the expense of such analyses.

It is to make the results of such work available in every-day practice that I have been experimenting for the past two and a half years upon the subject of clinical milk examination, the results of which work are here submitted. It is therefore the purpose of the present paper to set forth a simple means of breast-milk examination, such as can be readily applied by any intelligent practitioner; and while not pretending to the accuracy of the results afforded by complete quantitative analysis, still for practical purposes they will be found sufficient in ninety per cent. of the cases, at the same time being as trustworthy as methods commonly in use by the general practitioner in the examination of urine.

During the last twenty or thirty years considerable literature has accumulated in France and Germany upon the subject of breast-milk examination, but up to the date of Dr. Rotch's work nothing had been done in this country, and practically nothing in England.

In the examination of breast-milk, information is desirable upon the following points :

Reaction ; specific gravity ; microscopical appearances ; fat ; proteids ; sugar ; inorganic salts.

Reaction.—The reaction of breast-milk if freshly drawn, is alkaline in the great proportion of cases, seldom neutral, almost never acid. It can be easily tested by ordinary litmus paper.

Specific Gravity.—The specific gravity varies between 1029 and 1032, the average being 1031 at 70°F. in a good specimen ; abnormal variations are seen between the limits of 1017 and 1036. This may be taken with any small hydrometer. A urinometer will answer the purpose, although the instrument described below will answer better, since it can be employed with a smaller amount of milk. An increase in the fat lowers the specific gravity ; an increase in the other solids raises it.

Microscopical Examination.—Although much less important than other methods of examination, this is still useful

chiefly in the recognition of colostrum corpuscles and foreign matters occurring in milk, such as pus, blood, epithelial cells. Observations made upon the size and number of the fat globules have little or no practical value. Pus, blood and epithelial cells appear in various pathological conditions of the mammary gland, and their recognition is a matter of importance, since if present in any considerable quantity they make nursing, for the time at least, improper. Other signs of disease in the gland or the surrounding tissues are usually present, so that one hardly needs to resort to the microscopical examination of milk in cases of mastitis to show that it is abnormal.

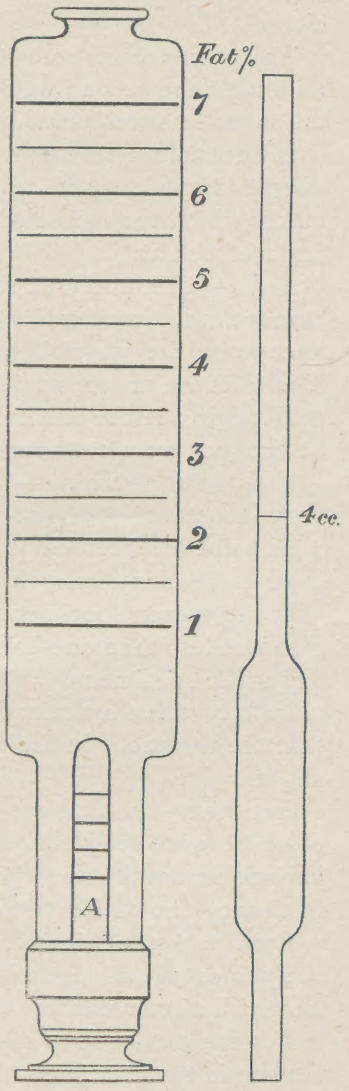

FIG. 1.

Colostrum corpuscles are normally present in milk during the first week of lactation in considerable numbers. From this time they diminish rapidly, and their appearance after the second week may be looked upon as pathological. These corpuscles do not seem to be in themselves important, but their presence is always an indication of other changes in the milk, not yet well understood, which makes it disagree with the infant. The causes of this colostrum-milk are many. It is seen occasionally during menstruation, also in cases of marked anæmia, and

frequently as a result of strong nervous impressions of any kind, such as fatigue, grief, fright and sexual excitement.

The presence of colostrum corpuscles in numbers in milk after the second week calls for a suspension of lactation, at least temporarily.

In determining the composition of milk what we most need is a knowledge of the proportions in which the two elements which vary most widely, viz.: the proteids and the fat, are present.

Salts.—The inorganic salts do not vary much in their amount in ordinary milk. As yet but little is positively known of the physiological effects of these variations. The salts are in too small amount to affect the specific gravity, and in the clinical examination of milk they may be dropped from consideration altogether.

Constancy of Sugar.—The proportion of the sugar is very constant in breast-milk under all circumstances. This point has been emphasized by all the chemists who have made many milk analyses.

In fifty-seven specimens analysed by Pfeiffer the variation was less than one-half per cent. from the average in forty-four specimens.

In forty-three examinations made by Leeds, he states that the variations in the proportions of sugar were very slight.

In twenty-five analyses made for me of samples, most of which were selected because they were abnormal the variation from the average was one-half per cent., or less in twenty-one of the cases.

From these data it may be considered established that the percentage of sugar in milk is remarkably constant under all circumstances.

Determination of Fat.—This is the most important feature in the analysis. Three methods for estimating fat may be employed. The first depends upon the fact that the opacity of milk is due to the floating fat globules, and the estimates of fat is made by a special instrument designed to measure the degree of translucency.

Several forms of apparatus have been devised and are used in Germany for this purpose. One of the best known is Vogel's instrument, but in my opinion it is greatly inferior to Feser's lactoscope. (See Fig. 1.) This instrument consists of a glass cylinder holding about three ounces, from the bottom of which rises a white porcelain stem A marked with strong black lines. Four cc. of milk is put into the cylinder with a graduated pipette, and water is added gradually, the instrument being shaken meanwhile until the black lines on the porcelain stem are faintly visible through the milky water. When the proper degree of translucency is reached the percentage of fat is read off at the level of the water upon the graduated scale marked on the cylinder, *e.g.*, water up to a certain part indicates four per cent. fat; up to another three per cent., etc.

The objections to this apparatus are that it is somewhat expensive, costing about $3.50, but most of all that it is not easy to know just at what point after the addition of water the reading is to be made. Without instruction in regard to this the observer is quite at sea, and may easily make a mistake of one or two per cent. These objections make an instrument of this kind rather too complicated for general use, although in the hands of an expert, the instrument if properly made is an excellent one for cow's milk but not quite so reliable for breast-milk.

The second method of estimating fat is that first published by Marchand, more than thirty years ago. In this the fat is separated from the milk by means of ether, and then precipitated from the ethereal solution by strong alcohol. Marchand's apparatus, modified by Conrad to enable the test to be made with a smaller quantity of milk is shown in the accompanying cut. (Fig 2.)

The test is applied as follows: The tube is filled to the line M with milk, then four or five drops of liquor sodæ are added, and then ether up to the line E. The tube is now corked and shaken strongly fifteen or twenty times; alcohol of ninety-five per cent. strength is now added up to line A. A slight excess is unimportant; the tube

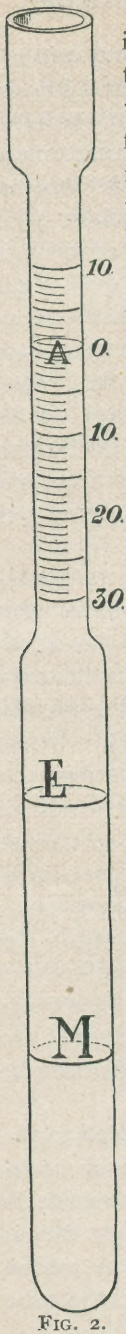

FIG. 2.

is now tightly corked and shaken fifteen or twenty times, then placed upright in a vessel of water at a temperature of 130° to 140°F. The fat globules in a few moments begin to rise rapidly and form a distinct layer at the top. At the end of half an hour the amount of fat may be read off on the graduations on the tube, and by reference to the accompanying table, taken from Conrad's article, the exact percentage of fat is calculated:

DEGREES MARCHAND.	FAT.
½	1.37 per cent.
1	1.49 "
3	1.95 "
5	2.42 "
7	2.89 "
9	3.35 "
11	3.82 "
13	4.28 "
15	4.75 "
17	5.22 "
19	5.56 "
21	6.15 "
23	6.61 "
25	7.07 "
27	7.54 "
29	8.00 "
31	8.47 "

This method of testing the fat is a fairly good one, but it is somewhat complicated and seems liable to quite wide variations, due to conditions in the milk not readily understood; certainly it is not so accurate as stated by Conrad in his monograph, and after employing it somewhat over two hundred times, I have not been wholly satisfied with it.

Neither of the above methods have seemed to fulfill the requisite simplicity necessary for general adoption, I have therefore made a number of experiments to determine whether the volume of cream rising in a given time upon

a specimen of milk bore sufficiently constant relation to the percentage of fat to make this a reliable guide for the calculation of the proportion of the fat.

The cream test has been made as follows: A glass-stoppered cylinder, graduated in one hundred parts and holding about ten cc. is filled with milk exactly to the upper line marked zero. A pipette should be used for the last few drops, care being taken not to allow the milk to run down the inner side of the tube since this obscures somewhat an exact reading. The cylinder is then corked and allowed to stand for twenty-four hours, as nearly at 70°F. as practicable. A variation of a few degrees on either side of this point is unimportant. If, however, the variations are wide the rapidity with which the cream rises is somewhat modified.

It is important that the milk should be freshly taken and handled as little as possible; also that the graduated cylinder should be scrupulously clean, otherwise the milk will often sour before the cream has had time to rise. This is particularly true in summer. After twenty-four hours the percentage is read off upon the graduated cylinder.

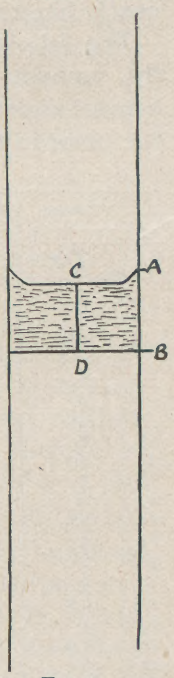

FIG. 3.

Fig. 3 shows the shape of the cream at the top of the tube. The percentage is to be read off between the points A and B, and not between C and D, since the latter will make an error of from one-half to one per cent.

In the great majority of the cases the lower line of the cream BE is sharply defined at the end of twenty-four hours. If this is not the case, the milk should stand for six hours longer before the reading is made. In rare cases at the end of twenty-four hours only a small amount of cream has risen, and the whole column of milk is nearly of a uniform white. This is due to some condition which

has prevented the cream in rising with the usual rapidity. Under these circumstances also, from six to twelve hours additional are required. These are, however, very rare exceptions. In nearly all the cases at the end of the twenty-four hours the lower line of the cream is sharply defined and the milk at the bottom of the tube has become translucent for an inch or so. It is these conditions which are to be secured before the reading is made, and it is only very exceptionally that more than twenty-four hours are required.

Relation of the Cream to the Fat.—By comparing the percentage of cream with that of the fat as determined by chemical analysis of the same specimen, it has been discovered that the ratio of the cream to the fat is very nearly five to three.

The following table shows the percentage of cream, the amount of fat as calculated in this manner, the amount as determined by chemical analysis and the size of the error in twenty-four cases:

	CREAM.	FAT (CALCULATED)	FAT BY ANALYSIS.	ERROR.
1	3%	1.8%	1.35%	.45%+
2	6	3.6	3.31	.29 +
3	7	4.1	3.86	.24 +
4	4	2.26	2.68	.42 —
5	2.5	1.50	1.23	.27 +
6	6.5	3.90	4.04	.86 +
7	5	3.00	2.78	.22 +
8	3	1.80	1.52	.28 +
9	3	1.80	1.74	.06 +
10	6	3.60	3.62	.02 —
11	4	2.26	2 95	.69 —
12	7	4.20	4.23	.03 —
13	6	3.60	3.48	.12 +
14	3.5	2.10	2.12	.02 —
15	5	3.00	3.78	.78 —
16*	4	2.40	2.79	.39 —
17	5	3.00	3.31	.39 —
18	2.5	1.50	1.54	.04 —
19	4	2.26	2.26	.00
20	3.5	2.10	2.17	.07 —
21	6	3.60	2.97	.63 +
22	6.5	3.90	3.53	.37 +
23	5	3.00	3.13	.13 —
24	5	3.00	4.51	1.51 —

*For cases 16 to 24 I am indebted to Dr. Charles Harrington of Boston, who made the analyses.

Thus in fourteen of these twenty-four cases the error was less than three-tenths per cent. In only five cases was it greater than one-half per cent. In only one did it reach one per cent. In all but two cases, Nos. 12 and 13, the cream was read off at the end of twenty-four hours. In these two tests which were made on the same day for some unexplained reason, the cream was very slow in rising and thirty-six hours were required before the conditions mentioned above as necessary were obtained.

It follows from the above, that when carefully made the volumetric cream test gives a very approximate idea of the percentage of fat in breast-milk, and that this is accurate enough for all practical purposes.

Variations in Fat and Proteids.—In striking contrast to this uniformity in the sugar are the wide variations met with in the fat and proteids, as is shown by the following table:

VARIATIONS IN FAT.

From 43 analyses by Leeds[1]	.....	2.11	to	6.89	per cent.
" " " Koenig	.....	1.71	to	7.60	" "
" 29 " " Personal[2]	.....	1.12	to	5.02	" "

VARIATIONS IN PROTEIDS.

From 43 analysis by Leeds[1]	....	.85	to	4.86	per cent.
" " " Koenig	.....	.57	to	4.25	" "
" 29 " " Personal[2]	.....	1.10	to	3.62	" "

It is just these wide variations in the composition of milk that are important for the practitioner to recognize.

Estimation of Proteids.—There is no known method of determining directly the percentage of the proteids in milk by a clinical examination. Nothing short of a full chemical analysis, and that by an expert, can be looked upon as absolutely accurate. It is possible, however, from a knowledge of the specific gravity and the percentage of fat to make an approximate calculation in regard to the percentage of proteids; enough to determine whether in a given case they are near the normal, or in very large, or in very small proportions.

[1] *Medical News*, July 21, 1883.

[2] The greater part of the analyses were made for me at the Chemical Laboratory of the College of Physicians and Surgeons, New York.

From the fact that the proportion of sugar is so nearly constant, and that the inorganic salts are in such small amount we may for clinical purposes consider the specific gravity as modified solely by the fat and the proteids.

Supposing now the proteids to remain the same, if the fat is high, the specific gravity will be high; but if the fat is low the specific gravity will be low.

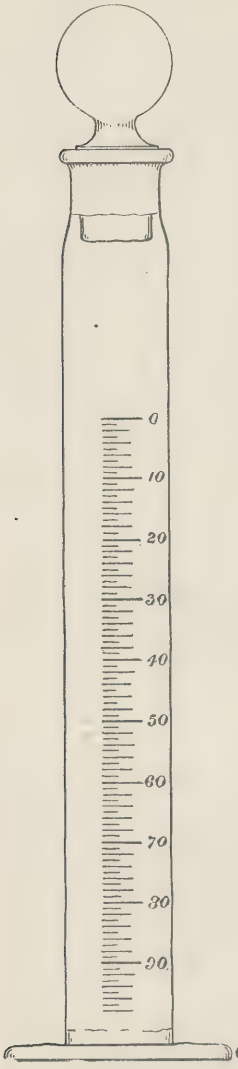

FIG. 4a.

FIG. 4b.

Supposing now the fat remains constant, if the proteids are high the specific gravity will be high; if the proteids are low the specific gravity will be low.

If therefore the fat and the specific gravity are known the proteids may be estimated as follows:

If the fat is found to be high, *e.g.*, eight to ten per cent. and the specific gravity is high, *e.g.*, 1033 to 1034 we may assume that the proteids are also high, otherwise the excessive fat would bring the specific gravity below the normal average.

If the fat is found to be low, three to four per cent., and the specific gravity high we may assume the proteids

to be nearly normal, since the high specific gravity is explained by the low fat.

If the fat is high, and the specific gravity low, the proteids may be assumed to be normal, since the variation in the specific gravity is explained by the low fat.

If the fat is low and the specific gravity is low, the proteids are also low, since otherwise the low fat would make the specific gravity above the average.

Of course it is only the wide variations of the proteids which can be recognized, but these are the most important in practice.

The application of the foregoing principles will readily be seen by reference to the accompanying table. It has been constructed from an experience with these methods in about four hundred samples of milk.

	SPECIFIC GRAVITY 70° F.	CREAM—24 HOURS.	PROTEIDS—(CALCULATED.)
Normal average.	1.031	7%	1.5%
Healthy variations.	1.028—1.029	8%—12%	Normal (rich milk)
" "	1.032—1.033	5%— 6%	" (fair milk)
Unhealthy "	Below 1.028	High (above 10%)	" or slightly below
"	" "	Normal (5%—10%)	Low
"	" "	Low (below 5%)	Very low (very poor milk)
"	Above 1.033	High	Very high (very rich milk)
"	" "	Normal	High
"	" "	Low	Normal (or nearly so)

Method of Determining the Composition of Milk.—This may briefly be summarized as follows: The specimen taken should be after the breast has been about half emptied, or else the entire amount yielded by the breast, since the first milk is more watery and the last is richer than the average. The specific gravity is taken with a small hydrometer* shown in Fig. 4 (b). With this instrument only one half ounce is required for the test. The cylindrical tube or creamometer* shown in Fig. 4 (a), is filled to the zero line and the cream read off at the end of twenty-four hours with the precautions previously mentioned. The percentage of fat may be calculated to be three-fifths of the cream. The knowledge of these

*This apparatus, consisting of two graduated cylinders and hydrometer, and printed directions, can be obtained from Eimer and Amend, 18th street and Third Avenue, New York City. Price $1.60.

two factors enables us to judge whether the proteids are nearly normal, very high or in very small amount.

Special attention is called to the fact that neither this nor even a chemical analysis will give any idea regarding the quantity of milk. It not unfrequently happens that the quality may be excellent and yet the nursing child doing wretchedly, because the quantity is very small. This is to be determined by other means. The most reliable symptoms of this condition are breasts which are soft and flabby at nursing time, and from which only a small quantity can be extracted by pressure or the pump. Long nursing *i.e.*, thirty or forty minutes, before the child is satisfied should also make one very suspicious that the milk is scanty. Weighing before and after nursing is conclusive. This requires scales which are accurate and sufficiently sensitive to indicate half ounces. Three or four observations should be made, at different hours in the day before a conclusion is reached.